

1 **CLAIMS**

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3 1. A method for fast channel changing in a multicast video distribution  
4 architecture, the method comprising:

5 detecting a channel change request that indicates a requested channel, the  
6 requested channel corresponding to a multicast group; and

7 transmitting a retained intra frame for the requested channel as a unicast  
8 communication.

9  
10 2. The method as recited in claim 1, further comprising:

11 caching at least one previous intra frame for each channel of a plurality of  
12 channels as a set of cached intra frames; and

13 retrieving, responsive to the detecting, the retained intra frame for the  
14 requested channel from the set of cached intra frames, the retained intra frame  
15 comprising a previous intra frame.

16  
17 3. The method as recited in claim 1, wherein:

18 the detecting comprises detecting the channel change request from a  
19 particular client; and

20 the transmitting comprises transmitting the retained intra frame to  
21 the particular client.

1           4.     The method as recited in claim 1, further comprising:  
2           synchronizing a multicast joining operation to the multicast group  
3           corresponding to the requested channel with regard to a next decodable frame of  
4           the requested channel.

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6           5.     The method as recited in claim 4, further comprising:  
7           buffering a video stream portion;  
8           wherein the synchronizing comprises determining when the next decodable  
9           frame is present within the buffered video stream portion.

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11          6.     The method as recited in claim 4, further comprising:  
12          buffering a video stream portion;  
13          wherein the synchronizing comprises determining when the retained intra  
14          frame reaches a joining time of the buffered video stream portion.

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16          7.     The method as recited in claim 4, further comprising:  
17          issuing a join command responsive to the synchronizing.

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19          8.     The method as recited in claim 7, wherein the issuing comprises:  
20                  transmitting a join instruction communication to a client that made  
21                  the channel change request, the join instruction communication stipulating  
22                  a time at which the client is to transmit a join message to a replication  
23                  point.

1           **9.**     The method as recited in claim 7, wherein the issuing comprises:  
2                 transmitting a join message to a replication point.

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4           **10.**    The method as recited in claim 1, further comprising:  
5                 caching at least one previous intra frame for each channel of a plurality of  
6 channels as a set of cached intra frames;  
7                 retrieving, responsive to the detecting, the retained intra frame for the  
8 requested channel from the set of cached intra frames, the retained intra frame  
9 comprising a previous intra frame;  
10                buffering a video stream portion;  
11                synchronizing a multicast joining operation to the multicast group  
12 corresponding to the requested channel based, at least partially, on whether a next  
13 intra frame is present within the buffered video stream portion; and  
14                issuing a join command responsive to the synchronizing.

1           **11.**     The method as recited in claim 1, further comprising:  
2           buffering a video stream portion;  
3           buffering at least two intra frames for each channel of a plurality of  
4 channels to produce buffered intra frames;  
5           retrieving, responsive to the detecting, the retained intra frame for the  
6 requested channel from the buffered intra frames with regard to a joining time of  
7 the buffered video stream portion;  
8           synchronizing a multicast joining operation to the multicast group  
9 corresponding to the requested channel based, at least partially, on whether a next  
10 decodable frame is outside the joining time; and  
11          issuing a join command responsive to the synchronizing.

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13          **12.**     One or more processor-accessible media comprising processor-  
14 executable instructions that, when executed, direct an apparatus to perform the  
15 method as recited in claim 1.  
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1           **13.**     A channel change server comprising:  
2           cached intra frames for a plurality of video streams, each respective video  
3 stream of the plurality of video streams associated with a respective channel of a  
4 plurality of channels;  
5           a channel change request detector that is capable of detecting channel  
6 change requests from individual clients of a plurality of clients; and  
7           a channel change request handler that is configured to respond to a detected  
8 channel change request from a particular client of the plurality of clients by  
9 extracting a most recent intra frame of a video stream associated with a requested  
10 channel from the cached intra frames and by transmitting the extracted most recent  
11 intra frame to the particular client using a unicast communication;  
12           wherein the channel change server is associated with multicast video  
13 distribution of the plurality of video streams.

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15           **14.**     The channel change server as recited in claim 13, further  
16 comprising:  
17           an intra frame cacher that is adapted to extract intra frames from the  
18 plurality of video streams and to cache at least a most recent intra frame for each  
19 video stream of the plurality of video streams.  
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1           **15.** The channel change server as recited in claim 13, further  
2 comprising:

3           a join command issuer that is adapted to send a join message to a  
4 replication point to cause the replication point to join the particular client to a  
5 multicast group corresponding to the requested channel.

6  
7           **16.** The channel change server as recited in claim 13, further  
8 comprising:

9           a join command issuer that is adapted to send a join instruction message to  
10 the particular client, the join instruction message stipulating an appointed time at  
11 which the particular client is to transmit a join message to a replication point.

12  
13           **17.** The channel change server as recited in claim 13, further  
14 comprising:

15           a synchronization determiner that is adapted to synchronize a multicast  
16 joining operation for the particular client to a multicast group corresponding to the  
17 requested channel with regard to a next intra frame of the video stream associated  
18 with the requested channel.

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20           **18.** The channel change server as recited in claim 17, wherein the  
21 synchronization determiner is further adapted to synchronize the multicast joining  
22 operation for the particular client to the multicast group corresponding to the  
23 requested channel using a quasi-predicted time of the next intra frame of the video  
24 stream associated with the requested channel.

1           **19.** The channel change server as recited in claim 17, further  
2 comprising:

3           a time-delayed buffered portion of the video stream that is associated with  
4 the requested channel;

5           wherein the synchronization determiner is further adapted to synchronize  
6 the multicast joining operation for the particular client to the multicast group  
7 corresponding to the requested channel with regard to the time-delayed buffered  
8 portion of the video stream that is associated with the requested channel.

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10           **20.** The channel change server as recited in claim 19, wherein a size of  
11 the time-delayed buffered portion corresponds to a likely or possible time period  
12 consumed when joining the particular client to the multicast group corresponding  
13 to the requested channel.

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15           **21.** The channel change server as recited in claim 19, wherein the  
16 synchronization determiner is further adapted to determine that a join command is  
17 to be issued when the synchronization determiner ascertains that the next intra  
18 frame is present within the time-delayed buffered portion of the video stream that  
19 is associated with the requested channel.

1           **22.**   The channel change server as recited in claim 19, wherein the  
2 synchronization determiner is further adapted to prompt issuance of a join  
3 command as soon as the next intra frame is ascertained to be present within the  
4 time-delayed buffered portion of the video stream that is associated with the  
5 requested channel even if the extracted most recent intra frame of the video stream  
6 associated with the requested channel has not been fully delivered to the particular  
7 client using the unicast communication.

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9           **23.**   A channel change server comprising:  
10           retained intra frames for a plurality of video streams, each respective video  
11 stream of the plurality of video streams associated with a respective channel of a  
12 plurality of channels;

13           a channel change request detector that is capable of detecting channel  
14 change requests from individual clients of a plurality of clients; and

15           a channel change request handler that is configured to respond to a detected  
16 channel change request from a particular client of the plurality of clients by  
17 extracting a retained intra frame of a video stream associated with a requested  
18 channel from the retained intra frames and by transmitting the extracted retained  
19 intra frame to the particular client using a unicast communication;

20           wherein the channel change server is associated with multicast video  
21 distribution of the plurality of video streams.

1           **24.** The channel change server as recited in claim 23, further  
2 comprising:

3           a video stream bufferer that is adapted to buffer each video stream of the  
4 plurality of video streams to create a plurality of respective buffered portions.

5  
6           **25.** The channel change server as recited in claim 23, further  
7 comprising:

8           a join command issuer that is adapted to send a join message to a  
9 replication point to cause the replication point to join the particular client to a  
10 multicast group corresponding to the requested channel.

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12           **26.** The channel change server as recited in claim 23, further  
13 comprising:

14           a join command issuer that is adapted to send a join instruction message to  
15 the particular client, the join instruction message stipulating an appointed time at  
16 which the particular client is to transmit a join message to a replication point.

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18           **27.** The channel change server as recited in claim 23, further  
19 comprising:

20           a synchronization determiner that is adapted to synchronize a multicast  
21 joining operation for the particular client to a multicast group corresponding to the  
22 requested channel with regard to a next decodable frame of the video stream  
23 associated with the requested channel.

1       **28.**    The channel change server as recited in claim 27, wherein the  
2   synchronization determiner is further adapted to synchronize the multicast joining  
3   operation for the particular client to the multicast group corresponding to the  
4   requested channel using a quasi-predicted time of the next decodable frame of the  
5   video stream associated with the requested channel.

6  
7       **29.**    The channel change server as recited in claim 27, further  
8   comprising:

9       a time-delayed buffered portion of the video stream that is associated with  
10   the requested channel;

11       wherein the synchronization determiner is further adapted to synchronize  
12   the multicast joining operation for the particular client to the multicast group  
13   corresponding to the requested channel with regard to the time-delayed buffered  
14   portion of the video stream that is associated with the requested channel.

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16       **30.**    The channel change server as recited in claim 29, wherein a size of  
17   the time-delayed buffered portion corresponds to a likely or possible time period  
18   consumed when joining the particular client to the multicast group corresponding  
19   to the requested channel.

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21       **31.**    The channel change server as recited in claim 29, wherein a size of  
22   the time-delayed buffered portion corresponds to a combination of a multicast  
23   joining time and an intra frame interval duration.

1           **32.**     The channel change server as recited in claim 29, wherein a joining  
2 time of the time-delayed buffered portion corresponds to a likely or possible time  
3 period consumed when joining the particular client to the multicast group  
4 corresponding to the requested channel.

5  
6           **33.**     The channel change server as recited in claim 29, wherein the  
7 synchronization determiner is further adapted to determine that a join command is  
8 to be issued when the synchronization determiner ascertains that the next  
9 decodable frame is proximate to a joining time of the time-delayed buffered  
10 portion of the video stream that is associated with the requested channel.

11  
12           **34.**     The channel change server as recited in claim 29, wherein the  
13 synchronization determiner is further adapted to prompt issuance of a join  
14 command as soon as the next decodable frame is ascertained to be entering a  
15 joining time of the time-delayed buffered portion of the video stream that is  
16 associated with the requested channel even if the extracted retained intra frame of  
17 the video stream associated with the requested channel has not been fully  
18 delivered to the particular client using the unicast communication.

1           **35.**     An arrangement for channel changing, comprising:

2           retention means for retaining at least one intra frame for each video stream  
3 of a plurality of video streams, each respective video stream associated with a  
4 respective channel of a plurality of channels;

5           detection means for detecting a channel change request from a client that  
6 indicates a requested channel, the channel change request from the client  
7 signifying a demand to switch from a first multicast group to a second multicast  
8 group that corresponds to the requested channel; and

9           handler means for handling the channel change request by transmitting a  
10 retained intra frame to the client via a unicast communication, the retained intra  
11 frame retained by the retention means from a respective video stream that is  
12 associated with the requested channel.

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14           **36.**     The arrangement as recited in claim 35, further comprising:

15           buffer means for buffering each respective video stream of the plurality of  
16 video streams to establish a respective buffered portion for each respective video  
17 stream; and

18           synchronization means for synchronizing a joining of the client to the  
19 second multicast group (i) with reference to a respective buffered portion for the  
20 respective video stream that is associated with the requested channel and (ii) with  
21 regard to a next decodable frame of the respective video stream that is associated  
22 with the requested channel.

1           **37.**    The arrangement as recited in claim 36, further comprising:  
2           issuance means for issuing a join command responsive to the  
3           synchronization means.

4  
5           **38.**    The arrangement as recited in claim 35, wherein the retention means  
6           comprises at least one of (i) buffering means for buffering the at least one intra  
7           frame for each video stream of the plurality of video streams and (ii) caching  
8           means for caching at least one intra frame for each video stream of the plurality of  
9           video streams.

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11          **39.**    The arrangement as recited in claim 35, wherein the arrangement  
12          comprises at least one server.

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14          **40.**    The arrangement as recited in claim 35, wherein the arrangement  
15          comprises one or more processor-accessible media.

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17          **41.**    A server that is configured to retain at least one independent frame  
18          for each video channel of a plurality of video channels that are being distributed  
19          using multicast communications and that is adapted to respond to channel change  
20          requests from clients by transmitting the retained at least one independent frame of  
21          a requested video channel to a requesting client using a unicast communication.

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23          **42.**    The server as recited in claim 41, wherein the server is capable of  
24          multicasting the plurality of video channels to the clients.  
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1           **43.**     The server as recited in claim 41, wherein the server is capable of  
2 synchronizing a multicast joining operation for the requesting client with regard to  
3 a next decodable frame of the requested video channel.

4  
5           **44.**     The server as recited in claim 43, wherein the next decodable frame  
6 of the requested video channel comprises a next independent frame.

7  
8           **45.**     The server as recited in claim 43, wherein the next decodable frame  
9 of the requested video channel comprises a next dependent frame.

10  
11           **46.**     The server as recited in claim 41, wherein the server is capable of  
12 synchronizing a multicast joining operation for the requesting client with regard to  
13 a next decodable frame of the requested video channel; and wherein the server is  
14 further adapted to refrain from transmitting the retained at least one independent  
15 frame of the requested video channel to the requesting client if transmission of the  
16 retained at least one independent frame jeopardizes timely reception of the next  
17 decodable frame of the requested video channel.

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19           **47.**     The server as recited in claim 41, wherein the server is further  
20 adapted to issue a join command irrespective of a complete or an incomplete  
21 delivery to the requesting client of the retained at least one independent frame of  
22 the requested video channel.

1       **48.**    A system comprising:  
2       at least one processor; and  
3       one or more media including processor-executable instructions that are  
4       capable of being executed by the at least one processor, the processor-executable  
5       instructions adapted to direct the system to perform actions comprising:  
6               multicasting a plurality of channels;  
7               retaining at least one intra frame for each channel of the plurality of  
8       channels; and  
9               transmitting a retained intra frame for a requested channel as a  
10      unicast communication responsive to a channel change request.

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12      **49.**    The system as recited in claim 48, wherein the system comprises a  
13      video provider and a channel change server.

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15      **50.**    The system as recited in claim 48, wherein the system comprises a  
16      video provider and a channel change server that are co-located.

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18      **51.**    The system as recited in claim 48, wherein the system comprises a  
19      channel change server that receives the plurality of channels from a video  
20      provider; and wherein the channel change server performs the action of  
21      multicasting the plurality of channels.

1           **52.**    The system as recited in claim 48, wherein the processor-executable  
2 instructions are adapted to cause the system to perform a further action  
3 comprising:

4                   synchronizing a multicast joining operation to a multicast group  
5                   corresponding to the requested channel with regard to a next decodable  
6                   frame of the requested channel.

7  
8           **53.**    The system as recited in claim 52, wherein the processor-executable  
9 instructions are adapted to cause the system to perform a further action  
10 comprising:

11                   buffering a video stream portion of a video stream that is associated  
12                   with the requested channel;

13                   wherein the action of synchronizing comprises an action of  
14                   determining when the next decodable frame is present within the buffered  
15                   video stream portion of the video stream that is associated with the  
16                   requested channel, the next decodable frame comprising a next intra frame.

1           **54.**    The system as recited in claim 52, wherein the processor-executable  
2 instructions are adapted to cause the system to perform a further action  
3 comprising:

4                   buffering a video stream portion of a video stream, which is  
5 associated with the requested channel, to a length that at least equals a sum  
6 of a multicast joining time and an intra frame interval duration;

7                   wherein the action of synchronizing comprises an action of  
8 determining when the next decodable frame is entering the multicast  
9 joining time part of the buffered video stream portion of the video stream,  
10 the next decodable frame comprising a next non-intra frame.

11  
12           **55.**    The system as recited in claim 52, wherein the processor-executable  
13 instructions are adapted to cause the system to perform a further action  
14 comprising:

15                   issuing a join command responsive to the synchronizing.  
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